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Chiu et al.

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(54) **BACKLIGHT MODULE**

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(51) **Int. Cl.**
G02F 1/13357 (2006.01)

(52) **U.S. Cl.**
USPC **362/612**; 349/62

(58) **Field of Classification Search** 362/600, 362/609–627
See application file for complete search history.

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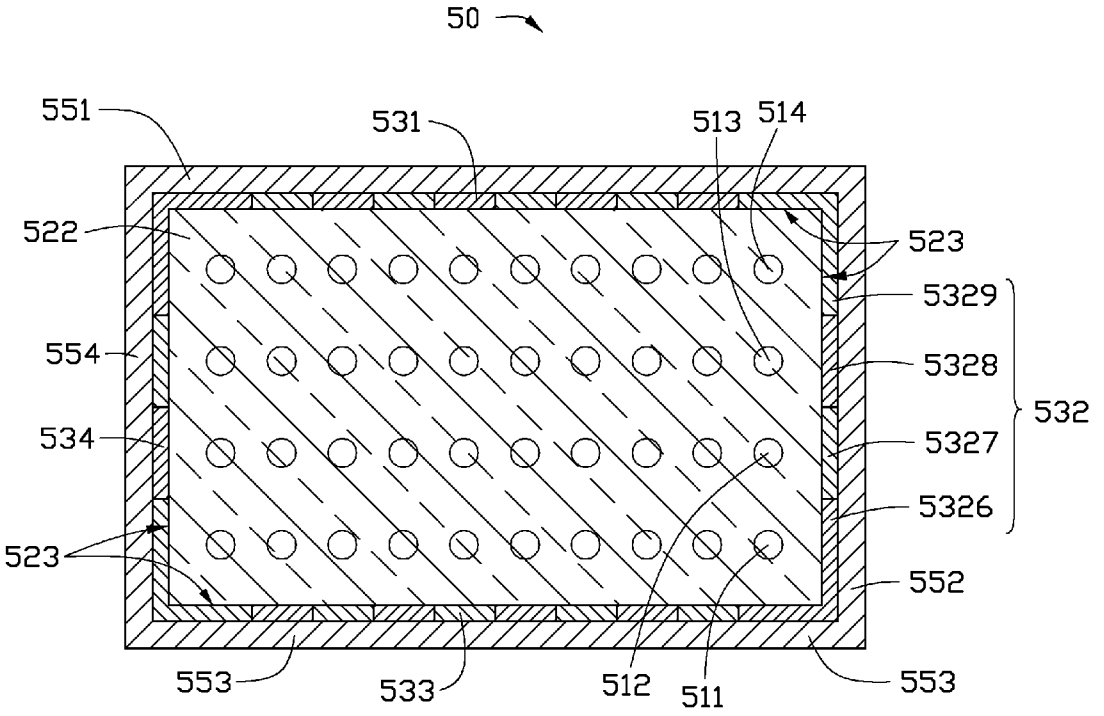
(57) **ABSTRACT**

An exemplary illuminating apparatus includes a light guiding plate, a light source facing a light input surface of the light guiding plate, and a complementary color element adjacent to the light source. The light source comprises a number of LEDs which emit light with at least two wavelengths. The at least two wavelengths light mix with each other to gain a white light. The complementary color element is configured for receiving light emitted from adjacent, outmost LED and converting the light into white light. The white light is reflected by the complementary color element and emits from the light guiding plate through the light output surface.

4 Claims, 8 Drawing Sheets



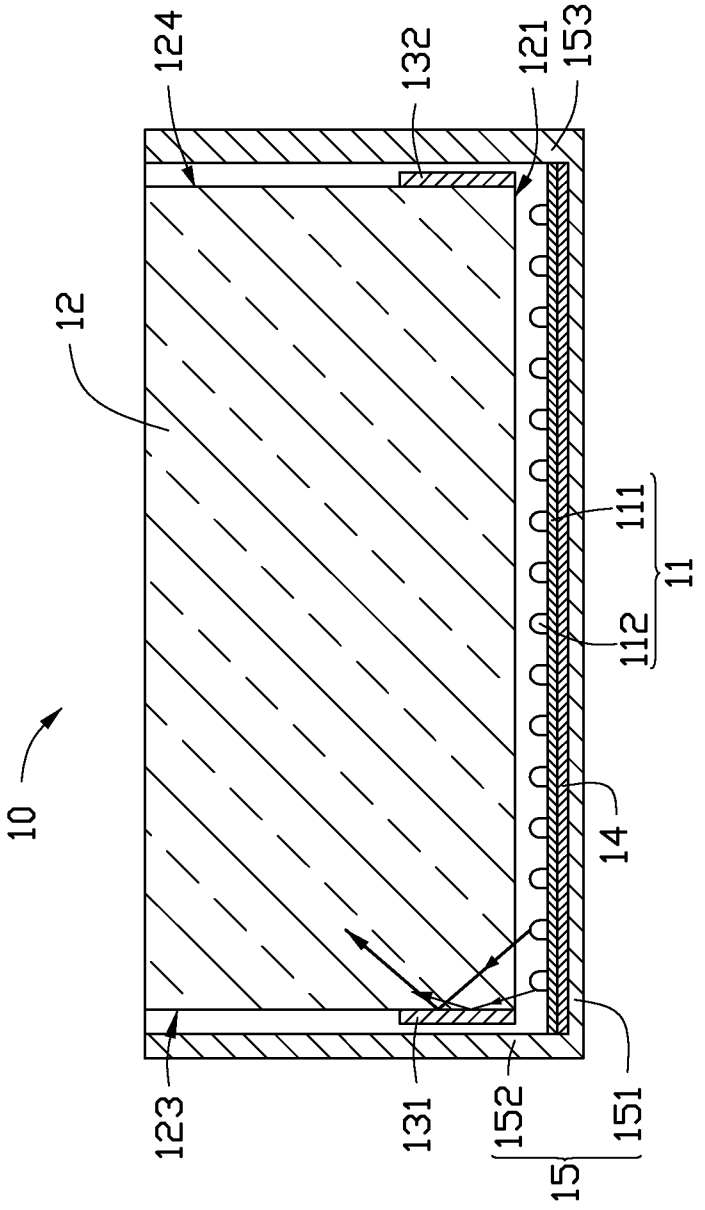


FIG. 1

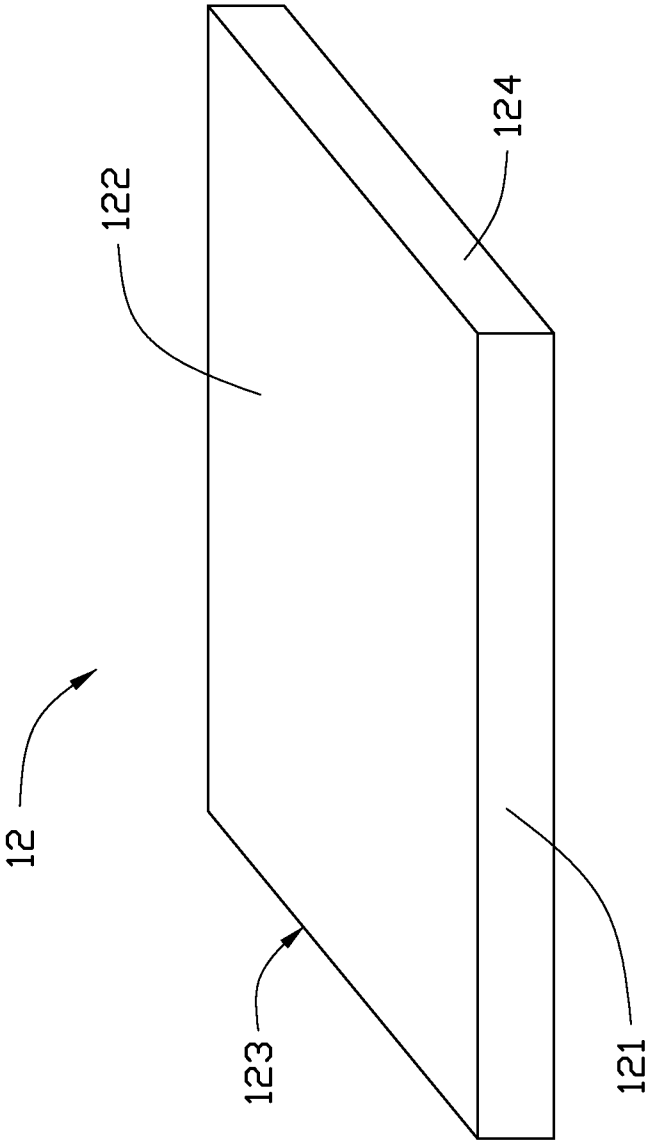


FIG. 2

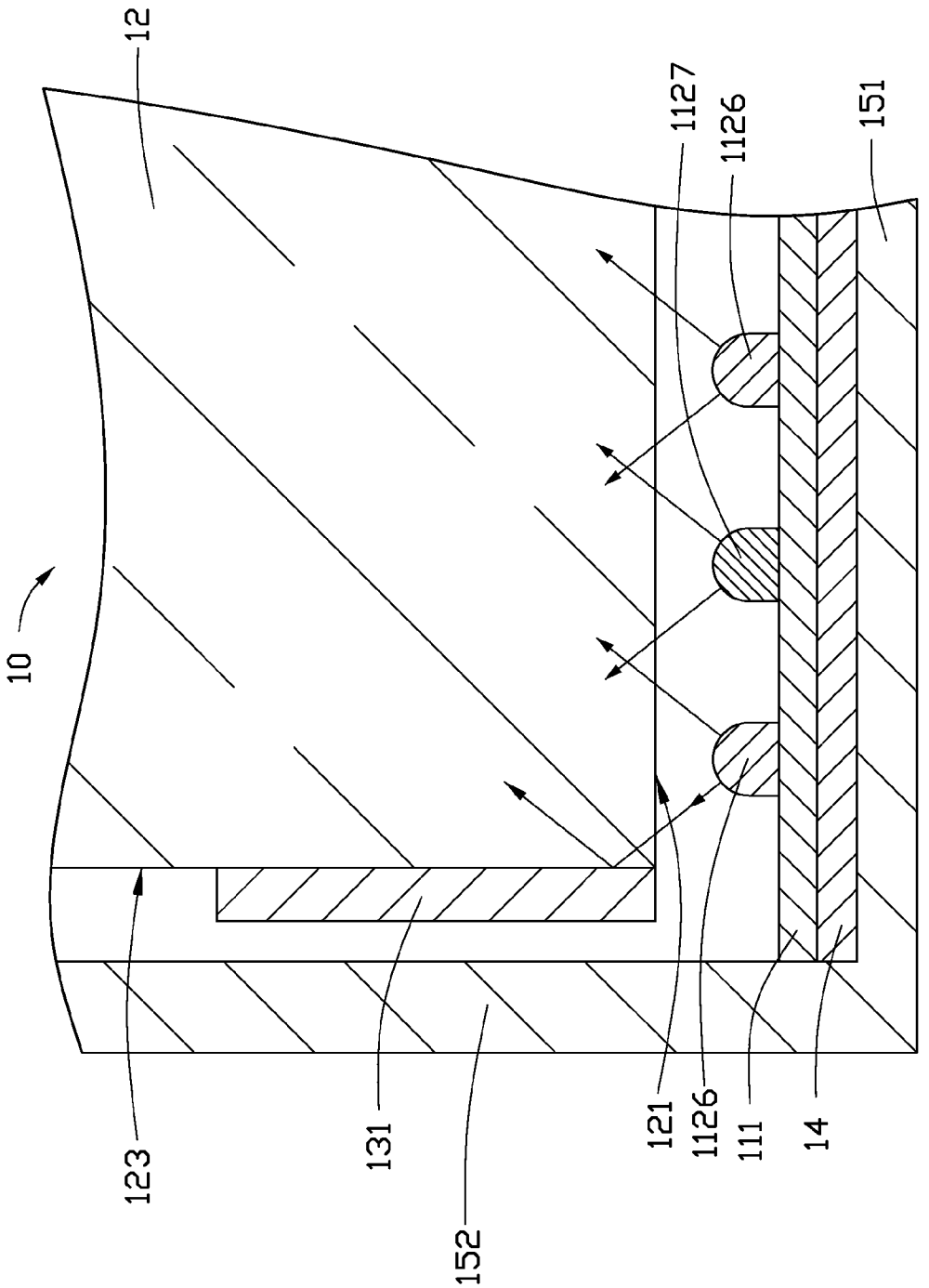


FIG. 3

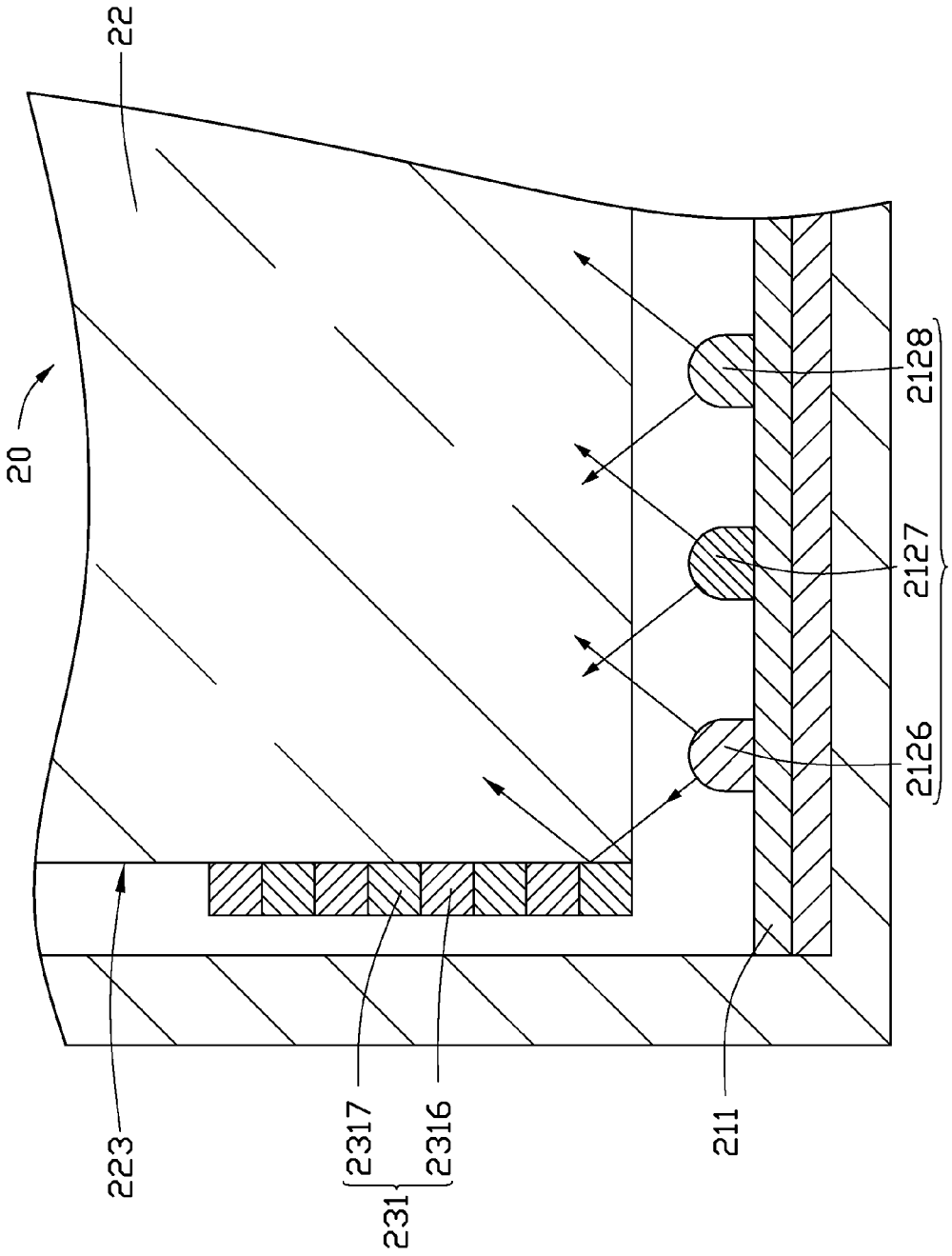


FIG. 4

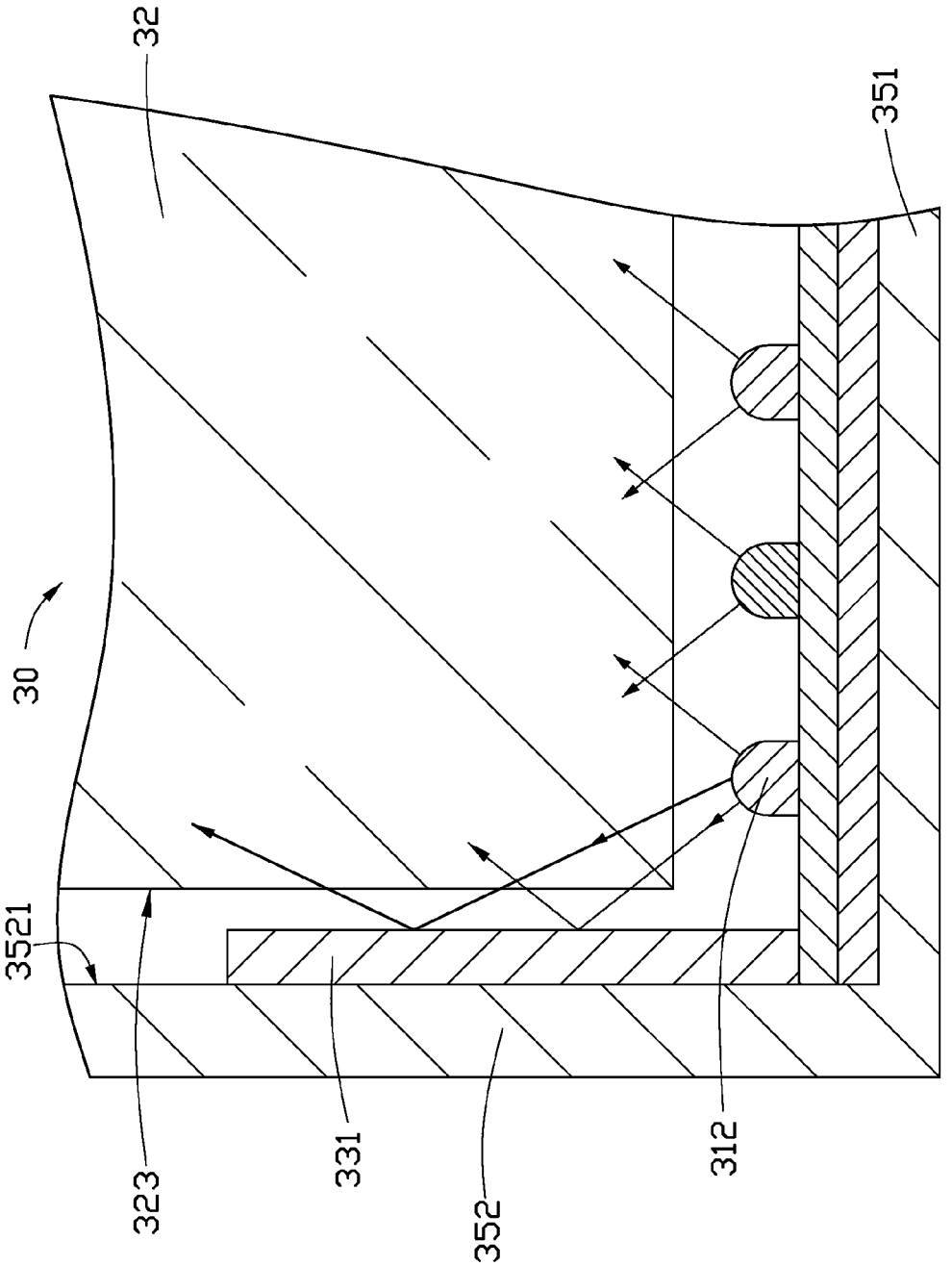


FIG. 5

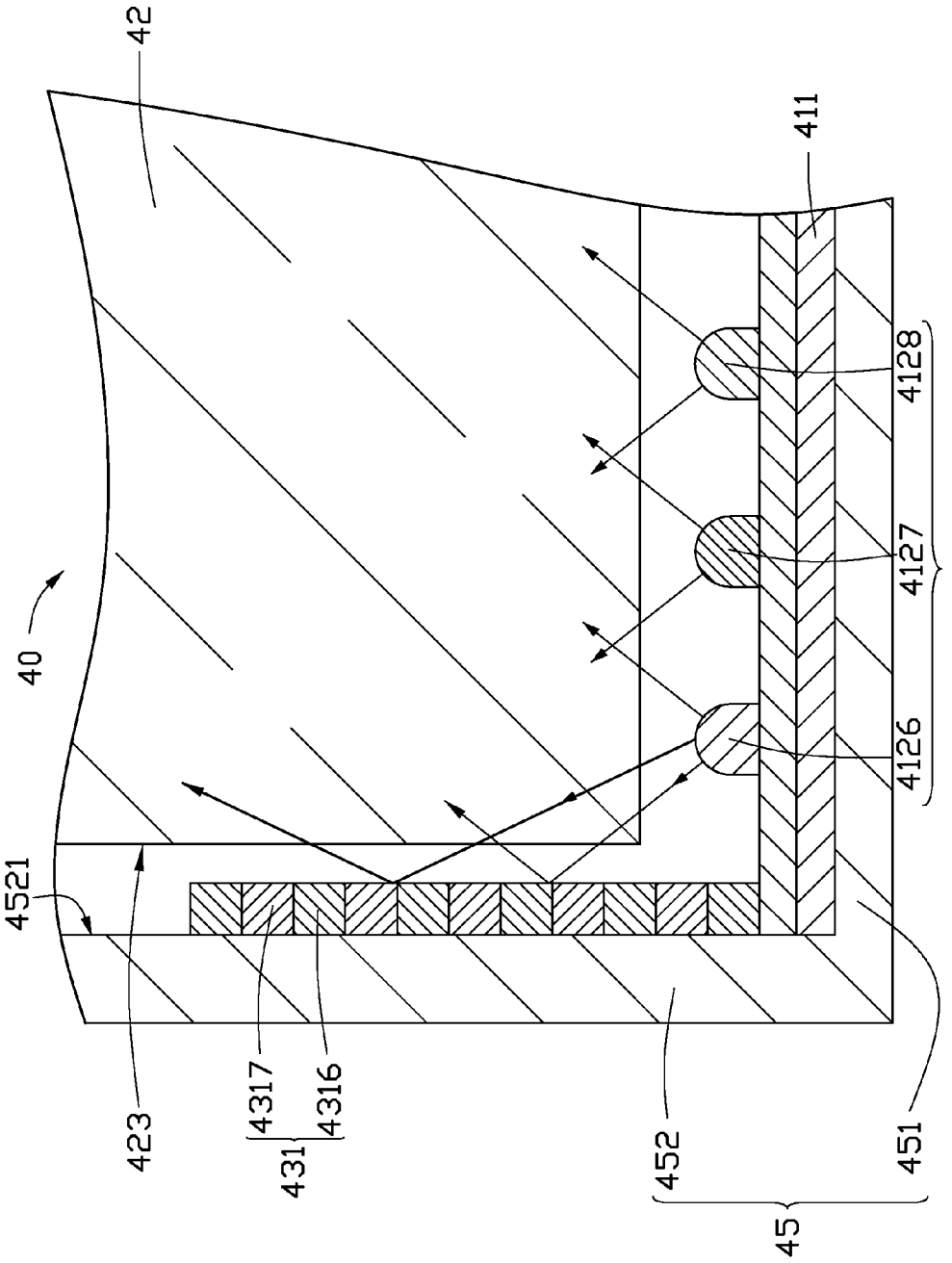


FIG. 6

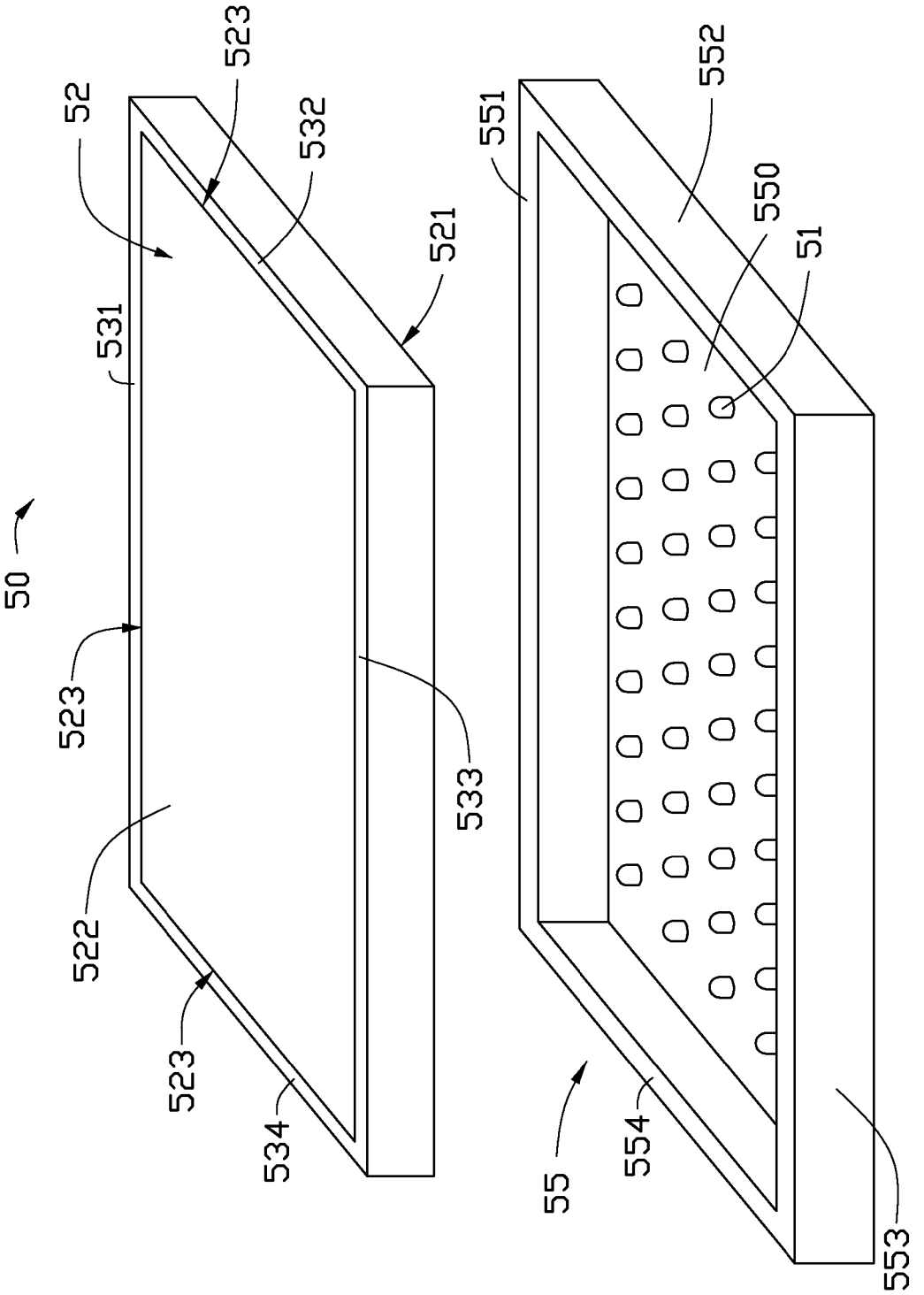

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FIG. 7

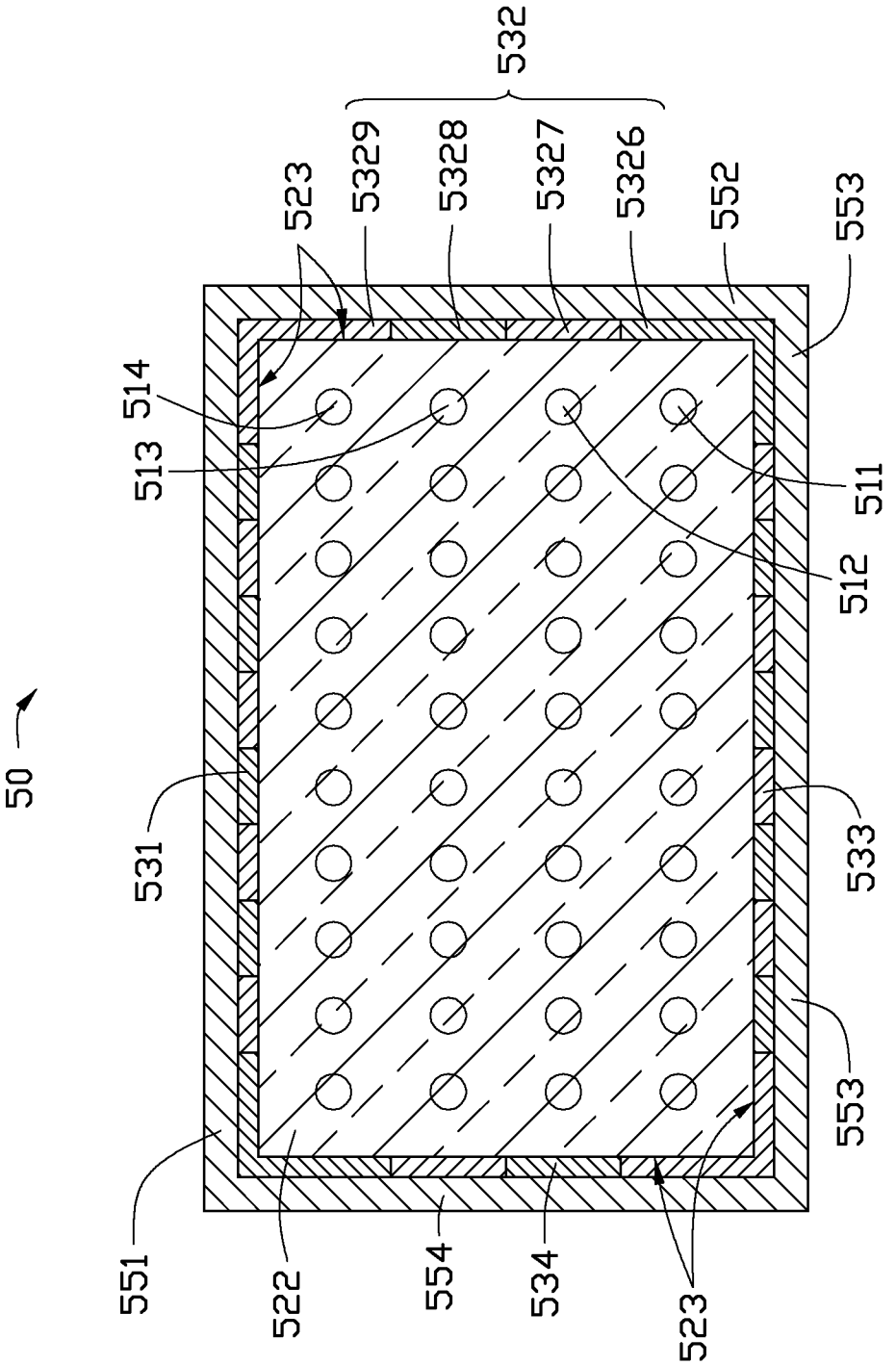
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FIG. 8

BACKLIGHT MODULE

BACKGROUND

1. Technical Field

The present disclosure generally relates to backlight modules, and particularly to a backlight module with satisfied light uniformity.

2. Discussion of Related Art

A typical LCD device includes a liquid crystal display panel, and a backlight module mounted behind the liquid crystal display panel. The backlight module mainly comprises a light source and a light guiding plate. The light guiding plate is generally made of a transparent acrylic plastic, and is used for guiding the light beams emitted by the light source in order to uniformly illuminate the liquid crystal display panel.

Nowadays, the light source of the backlight module includes red LEDs, green LEDs, and blue LEDs arranged on a substrate. White light is obtained by mixing light emitted by the red, green, and blue LEDs. However, the LEDs arranged on lateral sides of the substrate couldn't thoroughly mix. Light output from a light output surface of the light guiding plate may be non-uniform. In order to mix the light emitted by the light beams uniformly from the light output surface, a wavelength-selective reflectors is provided at a front of the light source to reflective light with the same colors; therefore, it can improve the mixing degree of the light via enhancing the distance that the light travels. Alternatively, reflectors are provided at lateral sides of the light guiding plate to reflect light emitted by the outmost light source to center area, and mix with light emitted by the center light source to obtain white light. Therefore, it can improve the light uniformity. However, because the light reflected by the reflectors for many times, the luminous intensity of the beams may be lessened to an unacceptable level.

Therefore, what is needed is a backlight module to overcome the above described shortcomings.

BRIEF DESCRIPTION OF THE DRAWINGS

Many aspects of the present embodiments can be better understood with reference to the following drawings. The components in the drawings are not necessarily drawn to scale, the emphasis instead being placed upon clearly illustrating the principles of the present embodiments. Moreover, in the drawings, all the views are schematic, and like reference numerals designate corresponding parts throughout the several views.

FIG. **1** is a cross-sectional view of an edge-lighting type backlight module, in accordance with a first embodiment of the present disclosure.

FIG. **2** is an isometric view of a light guiding plate of the backlight module of FIG. **1**.

FIG. **3** is a partially enlarged view of the backlight module of FIG. **1**.

FIG. **4** is a partially cross-sectional view of an edge-lighting type backlight module, in accordance with a second embodiment of the present disclosure.

FIG. **5** is a partially cross-sectional view of an edge-lighting type backlight module, in accordance with a third embodiment of the present disclosure.

FIG. **6** is a partially cross-sectional view of an edge-lighting type backlight module, in accordance with a fourth embodiment of the present disclosure.

FIG. **7** is an exploded view of a direct-type backlight module, in accordance with a fifth embodiment of the present disclosure.

FIG. **8** is a cross-sectional view of the backlight module of FIG. **7**.

DETAILED DESCRIPTION OF EMBODIMENTS

Reference will now be made to the drawings to describe various embodiments of the present backlight module in detail.

Referring to FIGS. **1-3**, an edge-lighting type backlight module **10**, in accordance with a first embodiment, includes an enclosure **15**, a light source **11** received in the enclosure **15**, a light guiding plate **12** facing the light source **11**, two complementary color elements **131**, **132** located at two corresponding side surfaces of the light guiding plate **12**, and a heat dissipation module **14** engaging with the light source **11**.

The enclosure **15** includes a base **151** and two opposite supporting portions **152**, **153** extending from two lateral ends of the base **151**. In the present embodiment, the supporting portions **152**, **153** are perpendicular to the base **151** of the enclosure **15**.

The light source **11** is mounted on the base **151** of the enclosure **15**. The light source **11** includes a substrate **111** and a number of light emitting diodes (LEDs) **112** arranged on the substrate **111** in a horizontal line and spaced from each other at equal intervals. In the present embodiment, the LEDs **112** include at least one type of first-wavelength LEDs **1126** and at least one type of second-wavelength LEDs **1127** alternately arranged on the substrate **111**. The first wavelength is different from the second wavelength. A first-wavelength light emitted from the first-wavelength LEDs **1126** and a second-wavelength light emitted from the second-wavelength LEDs **1127** mix with each other thereby to emit white light. In the present embodiment, two first-wavelength LEDs **1126** are respectively arranged on the lateral sides of the substrate **111**.

The light guiding plate **12** is received in the enclosure **15**. The light guiding plate **12** has a generally rectangular shape with a uniform thickness. The light guiding plate **12** includes a light input surface **121**, a light output surface **122** adjacent to and perpendicular to the light input surface **121**, and two opposite side surfaces **123**, **124** adjacent to the light input surface **121** and the light output surface **122**. The light input surface **121** faces the LEDs **112**. The side surfaces **123**, **124** respectively face the supporting portions **152**, **153** of the enclosure **15**. In the present embodiment, the side surfaces **123**, **124** are parallel to corresponding supporting portions **152**, **153** of the enclosure **15**.

The complementary color elements **131**, **132** are respectively located at the side surfaces **123**, **124** of the light guiding plate **12**. The complementary color elements **131**,**132** each have a color complementing the color of the light emitted by an adjacent, outmost LED **112** (i.e., the first-wavelength LED **1126** at a corresponding lateral side of the substrate **111**). In the present embodiment, the complementary color elements **131**, **132** are complementary color reflective films. The length of the complementary color elements **131**, **132** is less than that of the side surfaces **123**, **124** of the light guiding plate **12**. One end of each the complementary color elements **131**, **132** are substantially adjacent to the light input surface **121** of the light guiding plate **12**.

The complementary color element **131** is configured for receiving the first-wavelength light emitted from the first-wavelength LEDs **1126** arranged on the left end of the substrate **111** and converting the light into white light. Therefore, the white light is reflected by the complementary color ele-

ments **131** and emits from the light guiding plate through the light output surface **122**. In addition, the complementary color element **132** is configured for receiving the first-wavelength light emitted from the first-wavelength LED **1126** arranged on the right end of the substrate **111** and converting the light into white light; therefore, the white light is reflected by the complementary color elements **132** and emits from the light guiding plate **12** through the light output surface **122**. For example, when the LED **1126** arranged on the left end of the substrate **111** is blue LED, the complementary color element **131** is selected from a yellow reflective film. In one embodiment, the LED **1126** arranged on the right end of the substrate **111** is yellow LED, and the complementary color element **132** is blue reflective film. In another embodiment, the outmost LED **1126** arranged on the substrate **111** can be selected from green LED or red LED, and the corresponding complementary color elements **131**, **132** can be selected from purple or pale bluish green reflective film, respectively.

The heat dissipation module **14** is engaged with the substrate **111** of the light source **11** and configured for dissipating heat generated by LEDs **112** to environment air. In the present embodiment, the heat dissipation module **14** includes a number of sinks.

Since the backlight module **10** has complementary color elements **131**, **132** which have complementary color to the color of the light emitted by an adjacent, outmost LED **1126**, the light output from the light output surface **122** of the light guiding plate **12** is uniform.

Referring to FIG. **4**, an edge-lighting type backlight module **20** according to a second embodiment is shown. The backlight module **20** includes two complementary color elements, one is complementary color element **231** and the other one is not shown. The complementary color element **231** is located at a left side surface **223** of the light guiding plate **22**. The other complementary color element (not shown) is located at a right side surface of the light guiding plate **22**, which is symmetrically opposite to the complementary color element **231**. Differing from the backlight module **10**, the LEDs **212** of the backlight module **20** include a number of first-wavelength LEDs **2126**, a number of second-wavelength LEDs **2127** and a number of third-wavelength LEDs **2128**. The complementary color element **231** includes a number of first complementary color zones **2316** and a number of second complementary color zones **2317** arranged alternately along a vertical line.

The first-wavelength LED **2126**, the second-wavelength LED **2127** and the third-wavelength LED **2128** are different from each other, and arranged on the substrate **211** in a horizontal line. A first-wavelength light emitted from the first-wavelength LEDs **2126**, a second-wavelength light emitted from the second-wavelength LEDs **2127**, and a third-wavelength light emitted from the third-wavelength LEDs **2128** mix with each other and emit white light. In the present embodiment, the first-wavelength LEDs **2126**, the second-wavelength LEDs **2127** and the third-wavelength LEDs **2128** emit red, green, blue light, respectively.

The first and second complementary color zones **2316**, **2317** are alternately arranged and evenly spaced apart from each other. For example, the first-wavelength LED **2126** is a red LED, the first complementary color zones **2316** are green reflective films and the second complementary color zones **2317** are blue reflective films. Therefore, red light emitted from the red LED **2126** incidents to the first, second complementary color zones **2316**, **2317**. The first, second complementary color zones **2316**, **2317** cooperatively convert the light into white light and reflect the white light into the light guide plate **22** from the side surface **223**, and then the white light leaves the light guiding plate **22** from the light output surface **122**. It can be understood that, in the present embodiment, the complementary color element **231** can include more than two complementary color zones, or only includes a complementary color zone which is same as the complementary color element **131** in the first embodiment.

Referring to FIG. **5**, an edge-lighting type backlight module **30** according to a third embodiment is shown. The backlight module **30** includes two complementary color elements, one is complementary color element **331**, and the other one is not shown. Different from the backlight module **10** according to the first embodiment, the complementary color element **331** of the backlight module **30** is arranged on a left inner surface **3521** of a supporting portion **352** of an enclosure of the backlight module **30**. The other complementary color element (not shown) is symmetrically opposite to the complementary color element **331**, which is arranged on a right inner surface of another supporting portion **352** of the enclosure. In the present embodiment, the supporting portions **352** are perpendicular to the base **351**, and parallel to the side surface **323** of the light guiding plate **32**. The complementary color element **331** has a color complementary to the color of the light emitted by a corresponding adjacent, outmost LED **312**.

Referring to FIG. **6**, an edge-lighting type backlight module **40** according to a fourth embodiment is shown, differing from the backlight module **30** in the inclusion of the LEDs **412** which include a first-wavelength LED **4126**, a second-wavelength LED **4127** and a third-wavelength LED **4128**. The complementary color element **431** is arranged on an enclosure **45** of the backlight module, and includes a number of complementary color zones arranged alternately along a vertical line.

The first-wavelength LED **4126**, the second-wavelength LED **4127** and the third-wavelength LED **4128** are different from each other, and are arranged on the substrate **411** in a horizontal line. Light emitted from the first-wavelength LED **4126**, the second-wavelength LED **4127** and the third-wavelength LED **4128** mix with each other to produce white light. In the present embodiment, the first-wavelength LED **4126**, the second-wavelength LED **4127** and the third-wavelength LED **4128** respectively emit red, green, blue light.

The complementary color element **431** is arranged on an inner surface **4521** of the supporting portions **452** of the enclosure **45**. In the present embodiment, the supporting portion **452** is perpendicular to the base **451**, and parallel to a side surface **423** of the light guiding plate **42**. The complementary color element **431** has a number of complementary color zones. The complementary color zones are arranged alternately along a vertical line.

In the present embodiment, the complementary color element **431** includes a number of first complementary color zones **4316** and a number of second complementary color zones **4317**. The first and second complementary color zones **4316**, **4317** are alternately arranged and evenly spaced apart from each other, wherein the first complementary color zones **4316** are green reflective films and the second complementary color zones **4317** are blue reflective films. Therefore, red light emitted from the red LED **4126** arranged on the left end of the substrate **411** incidents to the first, second complementary color zones **4316**, **4317**. The first, second complementary color zones **4316**, **4317** cooperatively convert the light into white light and reflect the white light into the light guide plate **42** via the side surface **423**, and then white light emits from the light guiding plate **42**.

Alternatively the complementary color element **431** can include other colors. For example, when the LED **4126** at the lateral sides of the substrate **411** is blue LED, and the comple-

mentary color element **431** adjacent to the LED **4126** can be yellow. Also, the LEDs **412** can include a number of first-wavelength LEDs **4126** and a number of the second-wavelength LEDs **4127**.

Referring to FIGS. **7-8**, a direct-type backlight module **50** in accordance with a fifth embodiment is shown. The direct-type backlight module **50** includes an enclosure **55**, a light source **51** arranged in the enclosure **55**, a light guiding plate **52** opposite to the light source **51**, four complementary color elements **531**, **532**, **533**, **534** located at side surfaces of the light guiding plate **52**.

The enclosure **55** includes a base **550** and four supporting portions **551**, **552**, **553**, **554** upwardly extending from lateral sides of the base **550**. The base **550** cooperates with the supporting portions **551**, **552**, **553**, **554** to form a hollow rectangular parallelepiped. In the present embodiment, the supporting portions **551**, **552**, **553**, **554** are perpendicular to the base **550** and have a uniform height.

The light source **51** is received in the enclosure **55** and arranged on the base **550** of the enclosure **55**. In the present embodiment, the light source **51** includes a number of LEDs arranged in an array. The LEDs emit light with different colors, and the different colors light mix with each other to gain a white light.

The light guiding plate **52** has a generally rectangular shape with a uniform height. The light guiding plate **52** includes a light input surface **521**, a light output surface **522** opposite to the light input surface **521**, and four side surfaces **523** perpendicular to and sandwich between the light input surface **521** and the light output surface **522**. The light guiding plate **52** is received in the enclosure **55**, and the light input surface **521** faces the light source **51**. The side surfaces **523** of the light guiding plate **52** respectively face and are parallel to inner surfaces of the supporting portions **551**, **552**, **553**, **554**.

The complementary color elements **531**, **532**, **533**, **534** are respectively located at the side surfaces **523** of the light guiding plate **52**; therefore, inner surfaces of the complementary color elements **531**, **532**, **533**, **534** respectively face the four side surfaces **523** of the light guiding plate **52**.

In the present embodiment, the complementary color elements **531**, **532**, **533**, **534** each have a number of complementary color zones arranged alternately in a line. The complementary color zones each have a color complementary to the color of the light generated by the adjacent, outmost LED. In the present embodiment, the complementary color element **532** includes a number of complementary color zones **5326**, **5327**, **5328**, **5329**. The complementary color zones **5326**, **5327**, **5328**, **5329** respectively face the adjacent, outmost LEDs **511**, **512**, **513**, **514**, and complementary to the colors of the light emitted from the LEDs **511**, **512**, **513**, **514**, respectively. For example, when the LED **511** is yellow LED, the complementary color zone **5326** uses a blue reflective film. The complementary color zone **5326** receives yellow light emitted from the LED **511** and converts it into white light, and reflects the white light into the light guide plate **52** via the side surface **523** of the light guiding plate **52**. Then the white light emits from the light guiding plate **52** through the light output surface **522**. Therefore, the light output from the light output surface **522** of the light guiding plate **52** is uniform.

It is to be further understood that even though numerous characteristics and advantages have been set forth in the foregoing description of embodiments, together with details of the structures and functions of the embodiments, the disclosure is illustrative only; and that changes may be made in detail, especially in matters of shape, size, and arrangement of parts within the principles of the disclosure to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

What is claimed is:

1. A backlight module comprising:

a light guiding plate comprising a light input surface, a light output surface and two opposite side surfaces, the light input surface being adjacent and perpendicular to the light output surface, the two opposite side surfaces being adjacent and perpendicular to the light input surface and the light output surface;

a light source facing the light input surface of the light guiding plate, the light source comprising a plurality of LEDs, some LEDs emitting light with a first wavelength, and other LEDs emitting light with a second-wavelength different from the first wavelength, the first wavelength light mixing with the second wavelength light and obtaining white light; and

a complementary color element located at one of the side surfaces of the light guiding plate and adjacent to the light source, the complementary color element converting the light with the first wavelength emitted from a corresponding adjacent, outmost LED into white light, the white light being reflected by the complementary color element and emitting from the light guiding plate through the light output surface of the light guiding plate.

2. The backlight module of claim **1**, wherein the complementary color element is a complementary color reflective film.

3. The backlight module of claim **1**, further comprising an enclosure, the enclosure comprising a base and two opposite supporting portions extending from two lateral ends of the base, the light guiding plate being received in the enclosure, the light source being mounted on the base of the enclosure.

4. A backlight module comprising:

a light guiding plate comprising a light input surface, a light output surface adjacent and perpendicular to the light input surface, and two side surfaces adjacent and perpendicular to the light input surface and the light output surface;

a light source facing to the light input surface of the light guiding plate, the light source comprising a number of LEDs, the LEDs emitting light with at least two wavelengths, and the at least two wavelengths light mixing with each other to gain a white light; and

at least two complementary color elements adjacent to the light source and respectively located at the side surfaces of the light guiding plate, the at least two complementary color elements converting the light with the first wavelength emitted from adjacent, outmost LEDs into white light, and the white light being reflected by the at least two complementary color elements and emitting from the light guiding plate through the light output surface.

* * * * *